Information system for analyzing the competitive environmental of industry markets

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M. A. Medvedev, A. A. Detkov, and T. S. H. Moldobaev

Information System for Analyzing the Competitive Environmental of Industry Markets

M.A. Medvedev[1,2,a)], A.A. Detkov[1,b)], T.SH. Moldobaev[1,c)]

[1]*Ural Federal University, Mira 19, Yekaterinburg, Russia, 620002*
[2]*Institute of Industrial Ecology UB RAS, Sofia Kovalevskaya st., 20, Yekaterinburg, Russia*

[a)]Corresponding author: medvedevmaa@gmail.com
[b)]samik1982@mail.ru
[c)]moldobaevs@mail.ru

Abstract. The article addresses the questions of computer technologies application to assess the characteristics of the competitive environment of industry markets based on modern financial and economic models. The aim of the study is to develop an information system for identifying questionable counterparties that have entered into construction work contracts with state and municipal customers. The structure of the information system based on MongoDB and Neo4j non-relational databases is proposed. An algorithm is developed for collecting, processing and visualizing financial and economic information from open sources. The system includes data analysis methods that provide a calculation of indicators characterizing the financial condition of individual companies, as well as the level of market monopolization in the studied region. Testing the system on the example of the construction market of the Khanty-Mansiysk Autonomous District of Russia showed that it provides: identification of government contracts with unstable companies; assessment of the reliability of counterparties; assessment of the degree of competition in a particular market; identification of affiliated companies. The system can be used to support decision-making in the selection of contractors for construction work.

Keywords: Non-relational databases, big data, digital economy, monopolization, bankruptcy.

INTRODUCTION

Information technologies and systems are the modern and efficient tools for solving wide range of problems in socio-economic studies [1-10]. The Bid Data technologies, which are one of the priorities of the Digital Economy of the Russian Federation program, is used in various areas of the economy. Public companies, as well as financial and insurance companies are actively using solutions based on the use of BigData [11]. The popularity of big data is due to the possibility of optimizing the business processes of state and commercial companies and increasing the efficiency of their operating and investment activities. The main advantages of big data include:

- adoption of mathematically sound management decisions;
- reduction of financial risks;
- increase the speed of decision making due to complex analytics.

This project proposes the development of a decision support system using MongoDB and Neo4j non-relational databases. The main purpose of the considered financial instrument is the identification of inefficient economic transactions concluded on a contract basis .

The state provides citizens with open data on the activities of commercial entities in the form of financial statements, a list of founders and managers, tax payments, as well as information on public procurement in accordance with applicable law [12-13]. The data presented on official state information portals are not structured and decentralized, which complicates the definition of links between them for the construction of analytical models.

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To solve the identified problem, an algorithm for data acquisition is proposed, implemented using the python programming language and the pymongo and neo4jrestclient libraries. The scheme of information flows is shown in Figure 1.

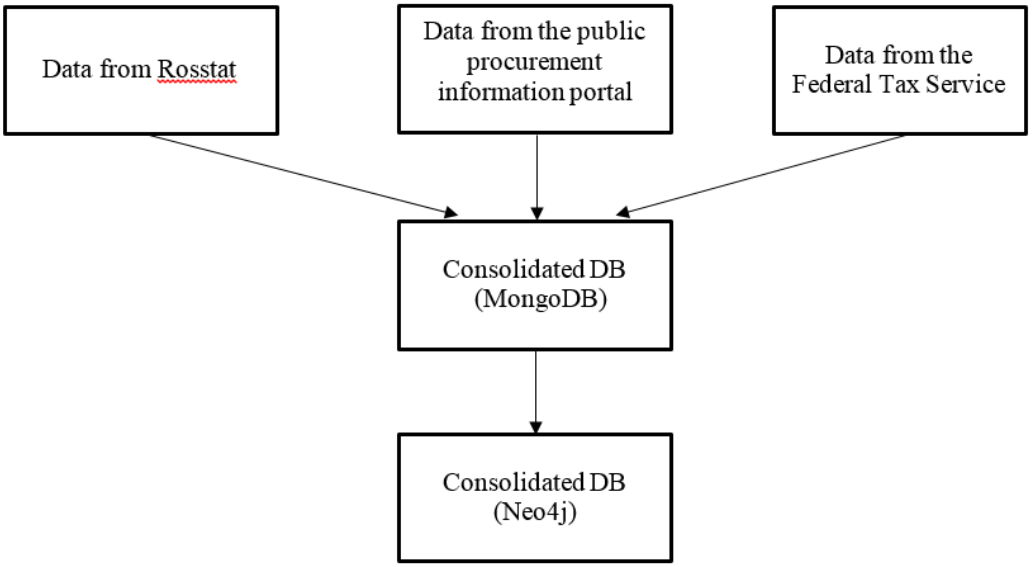

FIGURE 1. Scheme of information flows.

METHODS AND DATA

To process the collected information, you can use the classifier system, which provides an opportunity to determine the economic sector and the region in which commercial organizations conduct business activities. As part of this project, construction firms were considered in 9 districts of the Khanta-Mansi Autonomous District: Beloyarsky District, Berezovsky District, Kondinsky District, Nefteyugansky District, Nizhnevartovsky District, Oktyabrsky District, Sovetsky District, Surgut District, Khanty-Mansiysky District, as well as state and municipal organizations that have entered into contracts for construction and installation works in accordance with the requirements of Federal Law No. 44.

There are many methodologies for analyzing the financial and economic activities of companies for diagnosing bankruptcy of enterprises, which are reduced to the determination of financial condition and solvency. The application of the developed theory allows to identify unreliable counterparties, thereby reducing the risks when working with them. In addition, some approaches to testing bankruptcy were approved at the legislative level, such as the "Methodology for conducting the FTS to record and analyze the financial condition and solvency of organizations" based on calculating and comparing the following financial indicators (1, 2):

The degree of solvency on current liabilities (K_{CL})

$$Kcl = \frac{Currentresponsibility}{Averagemonthlysalesrevenue} \quad (1)$$

The current liquidity ratio (K_{LR})

$$Klr = \frac{Currentassets}{Currentresponsibility} \quad (2)$$

In addition, the use of budgetary funds associated with the conclusion of contracts for the execution of construction and contracting work may be illegal if the group of companies that are monopolists and do not allow

other organizations to show their production potential on the industry market. To assess the degree of monopolization of the market, you can use indicators such as (3,4):

Market concentration ratio (CR-N):

$$CR - N = \frac{\sum_{i=1}^{N} Vi}{\sum_{j=1}^{M} Vj}, \quad (3)$$

where, {Vi | i=1,..,N}⊆{Vj | j=1,..,M},
Vi-salesvolumeofthei-thcompany.

Herfindahl-Hirschman Index (IHH):

$$\text{Iнн} = \sum_{j=1}^{M} Sj^2, \quad (4)$$

where Sj - is the market share of the j-th company.

Based on the values obtained, the following types of monopoly power are distinguished:
Highly concentrated markets (70%<CR-3<100%; 2000<IHH<10000).
Moderately concentrate markets (45%<CR-3<70%;1000<IHH<2000).
Low concentrate markets (70%<CR-3<100%; 2000<IHH<10000).

THE EMPIRICAL RESULTS

Having determined the methods of diagnosing bankruptcy and the degree of monopoly power, as well as collecting and processing data on commercial and state organizations, you can construct a graph reflecting contractual relations on the use of budget funds for each region using the python programming language and the non-relational database Neo4j. The legend of the graph is described in Table 1.

TABLE 1. Graphic notation

Graph element	Description
Blue top	State or municipal organization with TIN
Green top	Solvent commercial organization with indication of TIN
Red top	Insolvent Commercial Organization with TIN
Orange top	Founder or head of a commercial organization with full name
Red connection	Contracts between a commercial firm and a state or municipal organization, indicating the total amount of contracts and their number during the year
Green connection	The relationship of the founder or leader to a commercial organization

Using the construction industry as an example in the Beloyarsky District, we will derive all state and municipal organizations, commercial firms, as well as their leaders and founders (Fig. 2).

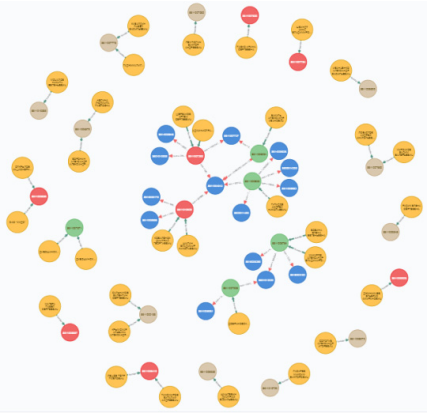

FIGURE 2. The result of a request for all commercial firms, state and municipal organizations

Based on the result, it can be concluded that only 6 out of 24 commercial companies entered into contracts for construction and installation works. Information on these firms is presented in Figure 3.

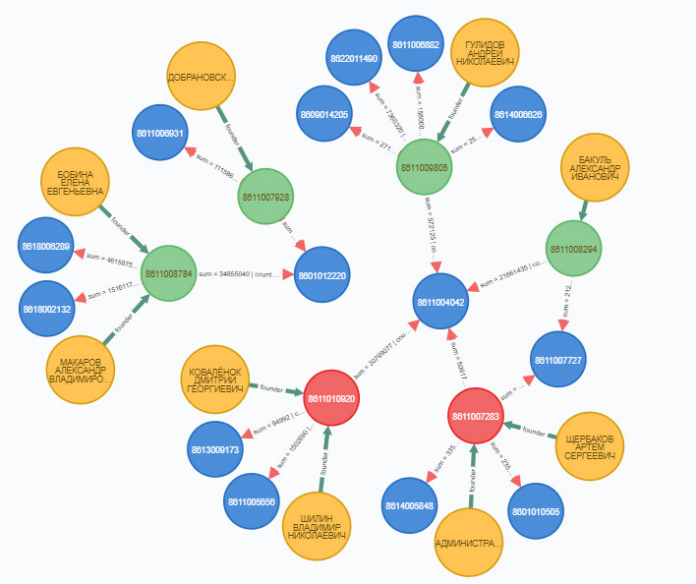

FIGURE 3. The result of a request for commercial firms that have entered into contracts with state or municipal organizations

CONCLUSION AND DISCUSSION

We will use the methodology for assessing the degree of monopolization described earlier to determine the structure of the construction market in each district of the Khanty-Mansiysk Autonomous Okrug. The results are presented in Table 2, as well as on the heat map, reflecting the distribution of regions into classes, based on the values of indicators of monopoly power (Fig. 4).

TABLE 2. Indicators of the degree of monopoly power in the regions of the KMAO-Ugra

Region	Market concentration ratio (CR-6), %	Herfindahl-Hirschman Index (Iнн), %*%	Market type
Beloyarsky district	96,71	6999,8	Highly concentrated
October district	88,04	5430,86	Highly concentrated
Kondinsky district	83,55	2006,09	Highly concentrated
Berezovsky district	85,69	1951,1	Moderately concentrated
Sovetsky district	72,2	1519,35	Moderately concentrated
Khanty-Mansiysk district	64,43	1253,47	Moderately concentrated
Surgut district	50,89	912,21	Low concentrated
Nefteyugansk district	52,05	614,93	Low concentrated
Nizhnevartovsk district	44,66	421,08	Low concentrated

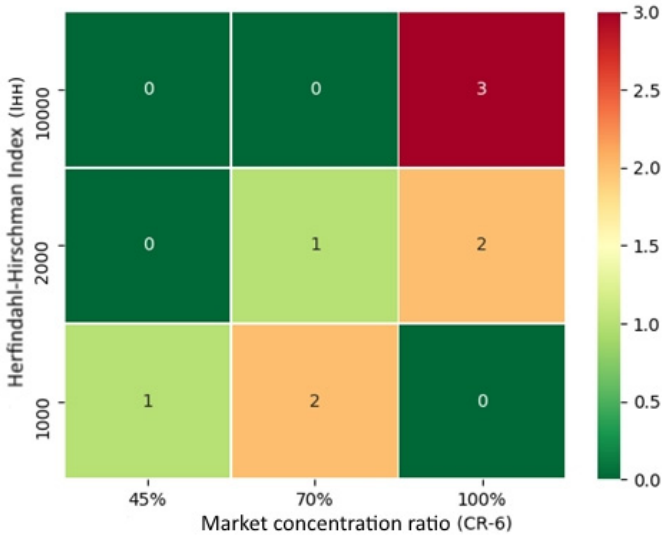

FIGURE 4. Distribution of regions into classes, reflecting the degree of monopolization of markets

Thus, the developed non-relational databases can be used for:
- Identification of government contracts with financially unstable commercial organizations;
- assess the reliability of counterparties;
- assessing the degree of competition in a particular market in a given sector of the economy;
- identify related parties;
- improving the efficiency of law enforcement and control and accounting authorities.

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